# Chapter H4: Recreational Benefits Analysis

## Introduction



This case study uses a benefit transfer approach to estimate the effects of improved recreational fishing opportunities due to reduced impingement and entrainment (I&E) in the Inland region. The Inland region includes all facilities that withdraw water from freshwater lakes, rivers, and reservoirs that are not included in the Great Lakes region.

Cooling Water Intake Structures (CWIS) withdrawing water from lakes, rivers, and reservoirs impinge and entrain many species sought by recreational anglers, including panfish, perch, walleye/pike, bass, and anadromous gamefish.[1] In addition, these facilities impinge and entrain forage species, resulting in indirect losses of recreational species that feed on those forage species. Inland CWIS are located in nearly every state, although most are found in the northeastern and south-central U.S. This case study uses estimates of the marginal value per fish from a number of studies conducted in the contiguous U.S. to estimate recreational fishing values for the Inland region.

The following sections discuss the sources of data and methodologies used in the analysis, and present the welfare analysis.

## H4-1 Data Summary

Many published studies value fishing trips and increases in catch rates on fishing trips. Primary studies have shown that anglers value fishing trips and that catch rates are one of the most important attributes contributing to the quality of their trips. For this analysis, EPA conducted a search of the academic literature to identify studies that estimated the marginal value of catching one additional fish. Studies were judged relevant if they valued at least one species affected by I&E, and if they were conducted in the contiguous U.S.[2] Based on these criteria, EPA identified 10 relevant studies.

Most of these studies provided direct estimates of the value of one additional fish, but a few reported values in other metrics, such as willingness-to-pay (WTP) for a doubling of catch rates. Based on information contained in the studies on catch rates and angling trips per season, EPA was able to convert these values for increases in catch rates into values per additional fish. Table H4-1 presents summary information about each of the 10 studies, including the species valued in the study, the WTP per additional fish reported in the study, the study methodology, and the study location.

[1] The specific species included in each of these groups are shown in Table H4-2.

[2] Benefit transfer analysis is ideally done with studies conducted in similar geographic locations to the location being valued. Because the Inland region includes sites from all over the U.S., estimates from any study that took place in the continental U.S. were included in this analysis.

**Table H4-1: Studies with Estimates of the Marginal Value of Freshwater Fish Species**

| Study Reference | Species Valued | WTP per Additional Fish Caught (2002$) | Study Type | Location of Study |
|---|---|---|---|---|
| Hicks, R., S. Steinback, A. Gautam, and E. Thunberg. (1999). Volume II: The Economic Value of New England and Mid-Atlantic Sportfishing in 1994. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. NOAA Technical Memorandum NMFS-F/SPO-38. | Small game fish (including striped bass) | $3.27 - $3.65 | Travel cost (RUM) | DE |
| McConnell, K.E. and I.E. Strand. (1994). The Economic Value of Mid and South Atlantic Sportfishing. University of Maryland, Report to the USEPA and NOAA. | Small game fish (includes striped bass) | $9.60 - $16.14 | Travel cost (RUM) | DE |
| Milliman, S.R., B.L. Johnson, R.C. Bishop, and K.J. Boyle. (1992). The Bioeconomics of Resource Rehabilitation: A Commercial-Sport Analysis for a Great Lakes Fishery. Land Economics. 68(2):191-210. | Perch | $0.33 | Contingent valuation | WI |
| Norton, V., T. Smith, and I.E. Strand. (1983). Stripers, The Economic Value of the Atlantic Coast Commercial and Recreational Striped Bass Fisheries. Maryland Sea Grant Publication No. 12. | Striped bass | $16.25 | n/a | Mid-Atlantic coast |
| Pendleton, L.H. and R. Mendelsohn. (1998). Estimating the Economic Impact of Climate Change on the Freshwater Sports fisheries of the Northeastern U.S. Land Economics. 74(4):483-96. | Panfish (warm- and cold-water species)[a] | $4.06 - $4.60 | Travel cost (hedonic; RUM) | ME, NH, VT, NY (excluding NYC) |
| U.S. EPA (2003). Watershed Case Studies Analysis for the Final Section 316(b) Phase Two Existing Facilities Rule. Part D: The Mid-Atlantic Region, and Part G: The Great Lakes. | Striped bass | $18.95 | Travel cost (RUM) | DE, NJ |
| | Walleye and pike | $11.55 | travel cost (RUM) | Great Lakes region |
| U.S. Fish and Wildlife Service. (1998). 1996 Net Economic Values for Bass, Trout and Walleye Fishing, Deer, Elk and Moose Hunting, and Wildlife Watching: Addendum to the 1996 National Survey of Fishing, Hunting and Wildlife-Associated Recreation. Report 96-2. | Smallmouth and largemouth bass | $4.13 | Contingent valuation | Northern region (includes DE, IA, IL, KS, KY, MD, MA, MO, NE, RI, VA, WV) |
| U.S. Fish and Wildlife Service and Stratus Consulting. (1999). Recreational Fishing Damages from Fish Consumption Advisories in the Waters of Green Bay. Prepared by Stratus Consulting Inc., Boulder, CO, for the U.S. Fish and Wildlife Service, U.S. Department of Justice, and U.S. Department of Interior. November 1. | Smallmouth bass | $1.82 | Contingent valuation (choice analysis) | WI, MI |
| | Yellow perch | $0.43 | | |
| | Walleye | $1.52 | | |
| Vaughan, W.J. and C.S. Russell. (1982). Valuing a Fishing Day: An Application of a Systematic Varying Parameter Model. Land Economics. 58:45-63. | Catfish | $0.77 | Travel cost | U.S. |
| Whitehead, J.C. and R. Aiken. (2000). An Analysis of Trends in Net Economic Values for Bass Fishing from the National Survey of Fishing, Hunting, and Wildlife-associated Recreation East Carolina University, Department of Economics. April. | Bass | $4.50 - $10.16 | Contingent valuation | U.S. |

[a] Two values for panfish from this study are not reported here because they are negative.

*Source: U.S. EPA analysis for this report.*

## H4-2 Benefit Transfer Methodology

Because estimates of WTP per additional fish were not available for every species affected by I&E, EPA assigned species affected by I&E into five categories: panfish, perch, walleye/pike, bass, and anadromous gamefish. Species that were not biologically associated with one of these groupings were classified based on their recreational angling characteristics. For example, the rainbow smelt, although not typically considered to be a panfish, was assigned to that category because of its small size (Wisconsin Sea Grant, 2003). The last column of Table H4-2 lists the species affected by I&E and the category to which they were assigned.

Based on information from the studies listed in Table H4-1, EPA calculated mean WTP per additional fish for each of the five species categories. EPA calculated the means by weighting different estimates taken from the same study so that every study had an equal overall weight, regardless of the number of estimates it presented. Table H4-2 presents summary statistics on value per additional fish, and the number of studies and number of observations used to calculate the values for each species group.

**Table H4-2: Value per Additional Fish Caught (2002$)**

| Species Group | Mean | Median | Minimum | Maximum | # of Studies | # of Observations | I&E Species Included in Category |
|---|---|---|---|---|---|---|---|
| Panfish | $2.55 | $4.06 | $0.77 | $4.60 | 2 | 3 | black bullhead, brown bullhead, black crappie, bluegill, channel catfish, crappie, freshwater drum, paddlefish, rainbow smelt, sunfish, other miscellaneous recreational species |
| Perch | $0.38 | $0.38 | $0.33 | $0.43 | 2 | 2 | yellow perch, white perch |
| Walleye/pike | $6.54 | $6.54 | $1.52 | $11.55 | 2 | 2 | muskellunge, sauger, walleye |
| Bass | $4.18 | $5.81 | $1.82 | $10.16 | 2 | 8 | smallmouth bass, white bass |
| Anadromous gamefish | $11.95 | $15.19 | $3.27 | $16.25 | 4 | 7 | striped bass, American shad |

*Source: U.S. EPA analysis for this report.*

In addition to calculating per-fish values for these species groupings, EPA estimated value per additional fish for recreational fish losses caused indirectly by losses of forage species due to I&E. The species of these fish are unknown, but EPA assumed that these fish have an average value per additional fish that is equal to the average value per additional fish of the panfish, perch, walleye/pike, and bass groups ($3.41 per fish).

To calculate welfare estimates, EPA multiplied the estimates of value per additional fish shown in Table H4-2 by the number of fish in each species group lost to I&E. These values were discounted at 3 percent and 7 percent over species-specific time periods, to reflect the fact that fish must grow to a certain size before they will be caught by recreational anglers. The recreational benefits under the final section 316(b) rule were further discounted to account for a 1-year lag between the date when installation costs are incurred and the installation of the required cooling water technology.

## H4-3 Welfare Estimates

Tables H4-3 and H4-4 provide annual welfare estimates for two policy scenarios at Inland facilities: completely eliminating I&E (the baseline scenario), and implementation of the final section 316(b) rule. As shown in Table H4-3, total baseline recreational angling losses for the Inland region are estimated to be 3.2 million fish, with a total undiscounted value of $11.6 million. Discounted at 3 percent, the total value is $10.6 million, and at 7 percent, $9.5 million. The largest portion of biological and monetary baseline losses are from indirect losses of predatory fish due to I&E of forage species, equivalent to 1.3 million age-one equivalent fish with an undiscounted value of $4.4 million. Losses of species classified as panfish are also large, equivalent to 1.1 million age-one equivalent fish with an undiscounted value of $2.7 million. Although the number of fish from the walleye/pike and bass groups is relatively small, the larger per fish value for these species results in monetized baseline losses from these groups of $2.3 million and $1.6 million, respectively. Biological and monetary losses of perch and anadromous gamefish are relatively small.

**Table H4-3: Baseline Losses for the Inland Region, by Species**

| Species | Recreational Value per Fish | Number of Fish Lost to I&E | Value of Loss | | |
|---|---|---|---|---|---|
| | | | 0% Discount Rate | 3% Discount Rate | 7% Discount Rate |
| **Panfish (total)** | **$2.55** | **1,072,917** | **$2,734,357** | **$2,491,154** | **$2,219,857** |
| bullhead | $2.55 | 15,212 | $38,769 | $35,300 | $31,344 |
| black crappie | $2.55 | 2,763 | $7,042 | $6,533 | $5,947 |
| bluegill | $2.55 | 5,057 | $12,889 | $11,906 | $10,758 |
| crappie | $2.55 | 277,464 | $707,125 | $638,445 | $561,250 |
| freshwater catfish | $2.55 | 232,854 | $593,435 | $566,251 | $534,255 |
| freshwater drum | $2.55 | 372,335 | $948,907 | $844,205 | $731,296 |
| other recreational species | $2.55 | 1,113 | $2,836 | $2,693 | $2,522 |
| paddlefish | $2.55 | 5,211 | $13,280 | $12,102 | $10,780 |
| rainbow smelt | $2.55 | 1 | $3 | $3 | $3 |
| sunfish | $2.55 | 160,905 | $410,071 | $373,716 | $331,704 |
| **Perch (total)** | **$0.38** | **29,681** | **$11,213** | **$10,090** | **$8,815** |
| white perch | $0.38 | 2,350 | $888 | $803 | $707 |
| yellow perch | $0.38 | 27,330 | $10,325 | $9,287 | $8,108 |
| **Walleye/Pike (total)** | **$6.54** | **353,852** | **$2,312,966** | **$2,094,599** | **$1,851,925** |
| pikes | $6.54 | 6 | $40 | $28 | $18 |
| sauger | $6.54 | 343,995 | $2,248,535 | $2,037,152 | $1,802,192 |
| walleye | $6.54 | 9,851 | $64,391 | $57,419 | $49,715 |
| **Bass (total)** | **$4.18** | **389,261** | **$1,628,233** | **$1,521,516** | **$1,396,014** |
| bass (Micropterus sp.) | $4.18 | 125,128 | $523,394 | $484,806 | $439,699 |
| white bass | $4.18 | 264,133 | $1,104,839 | $1,036,710 | $956,315 |
| **Anadromous Gamefish (total)** | **$11.95** | **42,284** | **$505,123** | **$445,399** | **$380,476** |
| American shad | $11.95 | 5,714 | $68,263 | $61,219 | $53,240 |
| striped bass | $11.95 | 36,569 | $436,861 | $384,180 | $327,236 |
| **Other (total)**[a] | **$3.41** | **1,300,103** | **$4,435,212** | **$4,075,847** | **$3,678,100** |
| other unidentified fish (from forage losses) | $3.41 | 1,300,103 | $4,435,212 | $4,075,847 | $3,678,100 |
| **Total** | **n/a** | **3,188,097** | **$11,627,105** | **$10,638,606** | **$9,535,187** |

[a] The "other" category includes indirect losses of fish that result from losses of forage fish due to I&E. The species of these fish is not known, so they are assumed to have a per fish value equal to the average value of perch, panfish, bass, and walleye/pike.

*Source: U.S. EPA analysis for this report.*

Table H4-4 presents the recreational fish losses prevented by the final section 316(b) rule in the Inland region, and the value of those prevented losses at a 0 percent, 3 percent, and 7 percent discount rate. Total prevented losses are 931,000 fish, or approximately one-third of total baseline losses. The undiscounted benefit to recreational anglers of this increase in fish catch is $3.3 million, and the discounted benefits are $3.0 million and $2.6 million at 3 percent and 7 percent, respectively. The largest portion of the benefits are attributable to reductions in losses of predatory species due to I&E losses of forage species. Prevented losses of this category of fish are 404,000 fish with a value of $1.4 million. The remaining benefits are due to reductions of I&E of panfish (317,000 fish with a value of $807,000), bass (121,000 fish with a value of $507,000), walleye/pike (63,000 fish with a value of $412,000), and anadromous gamefish (20,000 fish with a value of $239,000). Reduction of I&E for perch are insignificant.

**Table H4-4: Recreational Benefits of the Final Section 316(b) Rule for the Inland Region, by Species**

| Species | Recreational Value per Fish | Prevented Losses of Fish to I&E | Value of Loss | | |
|---|---|---|---|---|---|
| | | | 0% Discount Rate | 3% Discount Rate | 7% Discount Rate |
| **Panfish (total)** | **$2.55** | **316,625** | **$806,927** | **$717,283** | **$619,665** |
| bullhead | $2.55 | 3,631 | $9,254 | $8,239 | $7,107 |
| black crappie | $2.55 | 1,305 | $3,325 | $2,995 | $2,625 |
| bluegill | $2.55 | 2,290 | $5,835 | $5,239 | $4,564 |
| crappie | $2.55 | 52,268 | $133,207 | $117,184 | $99,633 |
| freshwater catfish | $2.55 | 79,270 | $202,022 | $188,376 | $172,512 |
| freshwater drum | $2.55 | 143,764 | $366,387 | $317,959 | $266,717 |
| other recreational species | $2.55 | 525 | $1,339 | $1,235 | $1,113 |
| paddlefish | $2.55 | 1,719 | $4,380 | $3,901 | $3,375 |
| rainbow smelt | $2.55 | 1 | $1 | $1 | $1 |
| sunfish | $2.55 | 31,852 | $81,177 | $72,154 | $62,019 |
| **Perch (total)** | **$0.38** | **5,899** | **$2,229** | **$1,951** | **$1,646** |
| white perch | $0.38 | 1,110 | $419 | $368 | $312 |
| yellow perch | $0.38 | 4,789 | $1,809 | $1,583 | $1,334 |
| **Walleye/Pike (total)** | **$6.54** | **62,967** | **$411,587** | **$362,685** | **$309,598** |
| pikes | $6.54 | 3 | $19 | $13 | $8 |
| sauger | $6.54 | 61,210 | $400,105 | $352,726 | $301,275 |
| walleye | $6.54 | 1,754 | $11,463 | $9,947 | $8,315 |
| **Bass (total)** | **$4.18** | **121,122** | **$506,640** | **$462,549** | **$411,840** |
| bass (Micropterus sp.) | $4.18 | 21,476 | $89,833 | $80,892 | $70,746 |
| white bass | $4.18 | 99,646 | $416,807 | $381,657 | $341,094 |
| **Anadromous Gamefish (total)** | **$11.95** | **19,966** | **$238,512** | **$204,186** | **$167,902** |
| American shad | $11.95 | 2,698 | $32,233 | $28,065 | $23,495 |
| striped bass | $11.95 | 17,268 | $206,280 | $176,121 | $144,408 |
| **Other (total)** [a] | **$3.41** | **404,031** | **$1,378,324** | **$1,229,752** | **$1,068,259** |
| other unidentified fish (from forage losses) | $3.41 | 404,031 | $1,378,324 | $1,229,752 | $1,068,259 |
| **Total** | **n/a** | **930,610** | **$3,344,219** | **$2,978,407** | **$2,578,910** |

[a] The "other" category includes indirect losses of fish that result from losses of forage fish due to I&E. The species of these fish is not known, so they are assumed to have a per fish value equal to the average value of perch, panfish, bass, and walleye/pike.

*Source: U.S. EPA analysis for this report.*

## H4-4 Limitations and Uncertainties

A number of issues are common to all benefit transfers. Benefit transfer involves adapting research conducted for another purpose in the available literature to address the policy questions at hand. EPA has identified a number of limitations and uncertainties in the use of benefit transfer to value recreational losses for the Inland region.

### H4-4.1 Considering Only Recreational Values

This study understates the total benefits of improvements in fishing site quality because estimates are limited to recreational use benefits. Many other forms of benefits, such as habitat values for a variety of species (in addition to recreational fish), non-use values, etc., are also likely to be important.

### H4-4.2 Applicability of Valuation Studies to Inland Region

This study classifies all inland sites that are not in the Great Lakes region as part of the Inland region. All I&E losses from the Inland region are aggregated in this analysis for the purpose of valuation. However, the studies used to provide values per fish are based on samples of recreational anglers from specific geographic regions. This may result in an unknown degree of error in the analysis. However, most plants with CWIS are located in the eastern region of the country, and since the majority of the studies included in this analysis are also from that region of the country, this may reduce uncertainty associated with the analysis.

### H4-4.3 Uncertainty in the Valuation Studies

There is considerable variation in estimates of per fish value provided by different studies and even within estimates taken from the same study. This variation can be attributed to a number of factors, including differences in geographic, economic, and social characteristics of the survey respondents; differences in study methods and analytical techniques; and potential biases and errors within the studies. By using an average of the values taken from several studies, EPA has attempted to minimize the uncertainty arising from these differences.

### H4-4.4 Values for Individual Species

Values were not available for every species affected by I&E. Therefore, EPA combined species into groups, based on biological and recreational angling characteristics of each species. To the extent that the average value for each category does not exactly match the value per fish for each species in that category, the benefit estimates may be overstated or understated.

### H4-4.5 Values for Predatory Species Affected by I&E of Forage Species

EPA used the average per fish value of species in the perch, panfish, bass, and walleye/pike groups as an approximation of the average per fish value of predatory species affected by I&E losses of forage species. Because the Agency was not able to determine how many fish of each predatory species were affected by losses of forage species, this estimated average per fish value may not accurately reflect the actual average value of fish in this category.